A Novel Method for Image Enhancement

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***Abstract*— In this paper a novel method for image enhancement using PDTDFB (Pyramidal Dual-Tree Directional Filter Bank) and interpolation has been adopted. Generally, in digital images since the different kinds of noise highly affects various image processing techniques it is always better to perform denoising first. Here, first of all the image is decomposed into two different layers namely low pass sub band and high pass sub band after which denoising is being performed on both the layers so as to smoothen the image. The smoothened image is then interpolated using edge-preserving interpolation and then amplified. Finally, the HR (High Resolution) image is being obtained by performing image composition.**

***Keywords*—High Resolution, PDTDFB, Denoising, Interpolation, Image Composition.**

I. Introduction

As we all know, these days' images of different sizes and quality are being delivered to layman from various resources like Internet, web cams, digital cams and mobile phones. But many a times the images obtained through these multimedia resources are of very low quality, which means they are LR (Low Resolution) images. So, there is a need of converting these LR images into HR images. Now a day many of the gadgets available in the market come up with on or the other method of converting the LR images to HR images. Most of them use either replication, bi-linear or bi-cubic methods of interpolation [1]. These three are the most common and simplest method of interpolation techniques available but the HR images produced are not at all up to the mark. To over come the problems caused by replication, bi-linear or bi-cubic methods certain better solutions like SR (Super- Resolution) method has been introduced [1]. SR method was also found to have certain limitations like having higher complexity in computation and larger memory consumption. Over coming the draw backs a single pass super- resolution technique has been introduced for generating HR image from a LR image. Certain other methods of interpolation like reconstruction based and polynomial interpolations also have been introduced [1]. But still complexity in computation persists to a greater extent. For over coming all these denoising have been introduced before applying the interpolation technique. Here a method is being put forwarded for keeping the sharp edges preserved and smooth the images in an efficient manner by applying bilateral filter, which is nothing other than a non-linear method [1]. In this paper a novel method for generating HR image using PDTDFB has been adopted for keeping the sharp edges preserved even for noisy images. The denoised images are then interpolated using edge-preserving interpolation, amplified and finally, the HR image is being obtained by performing image composition.

II. Proposed System

Fig. 1 illustrates the proposed systems, which consist of the following steps:

- Image Decomposition and Denoising.
- Edge preserved Interpolation.
- Amplification and Image Composition.

Each step has been described in detail.

A. Image Decomposition and Denoising.

At the very beginning the image decomposition is done on the LR image by the method of PDTDFB, which is nothing but a shiftable complex directional pyramid [2]. Actually the PDTDFB design takes place in two stages:

- Multi resolution decomposition is performed by designing two FBs(Filter Banks). Either of the FBs is two channelled with two filters [2].

- For Directional Filter Banks (DFBs) fan FBS are designed [2].

Thus, the out come of the PDTDFB on the LR image would be the low pass sub band and high pass sub band on to which the denoising is being performed by the bilateral filter.The bilateral filtering is a technique used for edge preserving smoothing which in effect blurs the image although maintains the sharpness of edges [1]. As it has two Gaussian filters, the computation complexity is not so high. For that reason, this filter is used in various multimedia devices. Let x and y denote the two dimensional positions of the two locations namely current and neighbouring. Also, the pixel values are represented by I (x) and I (y) for LR image. Here, pixel location affinity is represented by c () and s (). The result of filtering is as follows [1]:

$$\mathbf{I}_b(\mathbf{x}) = \frac{1}{k(\mathbf{x})} \sum_{\mathbf{y} \in \Omega} c(\mathbf{x},\mathbf{y}) s(\mathbf{I}(\mathbf{x}), \mathbf{I}(\mathbf{y})) \mathbf{I}(\mathbf{y})$$

In the following equation the normalization is represented by k () and the current location with the neighbouring pixel location is denoted by Ω.

$$k(\mathbf{x}) = \sum_{\mathbf{y} \in \Omega} c(\mathbf{x},\mathbf{y}) s(\mathbf{I}(\mathbf{x}), \mathbf{I}(\mathbf{y}))$$

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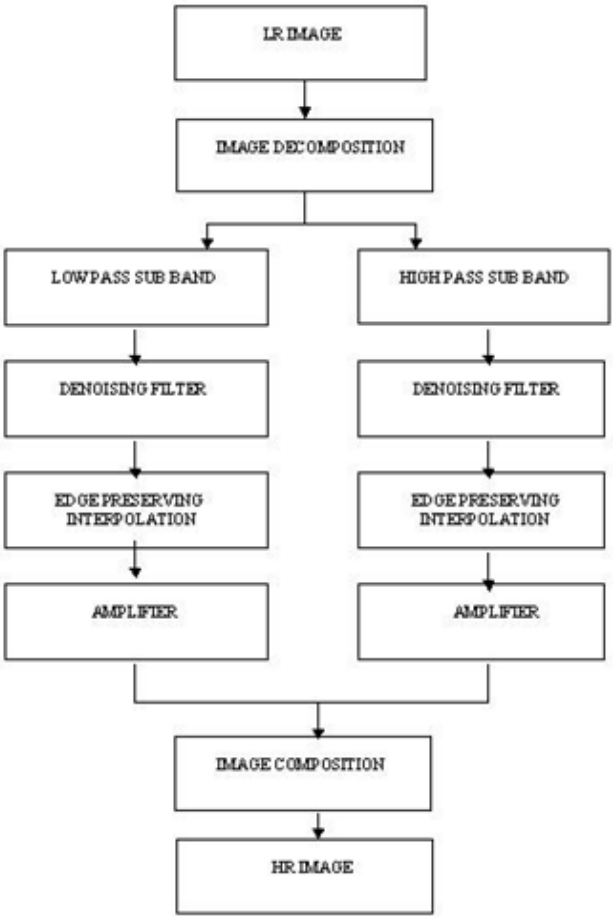

Fig. 1 Architecture of the Proposed System.

A. Edge preserved Interpolation.

The denoised layers of the image are interpolated one by one. Here an edge-based interpolation technique is being used, which uses the directional correlation between the pixels [1]. Edge directions are indicated by [1]:

$$d_a^* = \arg\min_{d\in\{1,2\}} \left(| A_d - B_d | \right)$$

$$d_b^* = \arg\min_{d\in\{1,2,3\}} \left(| A_d - B_d | \right)$$

The interpolation of missing pixels are denoted by [1]:

$$\mathbf{I}(\cdot) = \frac{A_{d_a^*} + B_{d_a^*}}{2}$$

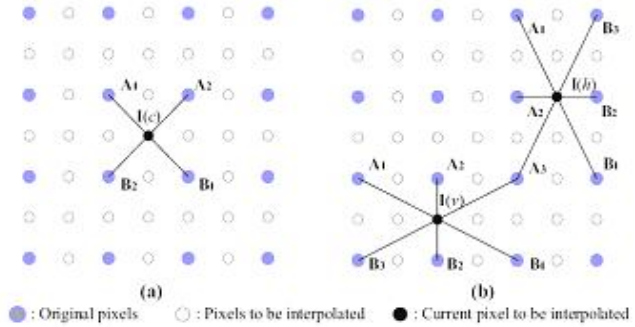

Fig 2 [1]: Two Interpolation configurations.
(a) I(c) configuration (b) I (v), I (h) configuration

C. Amplification and Image Composition.

The interpolated images are amplified and then image composition is being done. Here adaptive unsharp masking technique is being done as part of the image composition [1]. There are certain advantages for the adaptive unsharp masking unlike the normal masking technique. The noises in the smooth area are being prevented from getting highlighted. To avoid certain artefacts the area with high contrast medium enhancement is being adopted and vice versa. On the whole the adaptive unsharp masking helps in preserving the structure of the image without getting altered.

III. EXPERIMENTAL RESULTS

In order to test the proposed system the application has been run on various images as indicated in the fig 3.The weighting factors are indicated by the following equations:

$$\gamma_1 = \sum | E_b(\mathbf{x}) |^2 / \sum | E_d(\mathbf{x}) |^2.$$

$$\gamma_2 = \sum | E_b^{in}(\mathbf{x}) | / \sum | \hat{E}_d^{in}(\mathbf{x}) |.$$

IV. CONCLUSION

In this paper, a novel method for image enhancement using PDTDFB has been adopted. Other than PDTDFB the main highlight is the edge preserved interpolation technique, which plays a major role in converting a LR image to HR image. After which the adaptive unsharp masking technique is being done as part of the image composition technique, which further adds on to its efficiency. The proposed system would be highly beneficial in image demosacing for digital cameras using color filter array like Bayer pattern. The images obtained through various multimedia resources can be easily converted in HR images by adopting this proposed system.

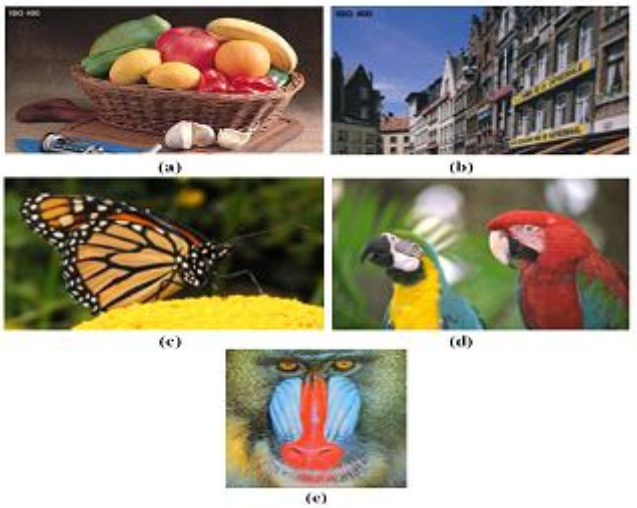

Fig. 1 Test Images. (a) Fruit. (b) Café. (c) Monarch. (d) Parrot. (e) Baboon.

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TABLE I
COMPARISON BETWEEN AVG.PSNR

Image	Noise Variance	Bilinear [5] + Bilateral filter	Edge based [4]+ Bilateral Filter	Novel Interpolation [1] + Bilateral Filter	Proposed (Approx.)
Fruit (1280 x 768)	10	25.91	25.91	27.96	27.98
	20	22.85	22.87	24.11	24.20
	30	20.73	20.74	21.79	21.96
Cafe (1280 x 768)	10	23.94	23.93	24.55	24.89
	20	20.03	20.12	20.34	20.51
	30	16.68	19.70	19.98	19.99
Parrot (768 x 512)	10	26.08	26.00	26.64	26.72
	20	23.29	23.25	23.76	23.91
	30	20.50	20.48	20.85	20.94
Monarch (1280 x768)	10	25.29	25.42	25.97	25.98
	20	22.76	22.80	23.31	23.41
	30	20.32	20.37	20.72	20.89
Baboon (512 x 512)	10	23.60	23.55	25.17	25.32
	20	21.62	21.25	23.89	23.95
	30	19.64	19.61	20.48	20.54

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